

ABSTRACT

[00113] The *in vitro* polymerization of silica, silicone, non-silicon metalloid-oxane and metallo-oxane polymer networks, by combining a catalyst and a substrate to polymerize the substrate to form silica, polysiloxanes, polymetalloid-oxanes polymetallo-oxanes (metal oxides), polyorganometalloid oxanes, polyorganometallo oxanes, and the polyhydrido derivatives thereof, at about neutral pH. The nanostructure-directing catalysts have a nucleophilic functionality and a hydrogen-bonding acceptor group, and include: silicateins, enzymes that work by a mechanism functionally related to that of the silicateins; self-assembling peptides related to those synthesized and demonstrated capable of acting as biomimetic substitutes for the silicateins; non-peptide-based synthetic polymers containing a nucleophilic group and a hydrogen bonding amine such that the polymer functions by a mechanism of action related to that of the silicateins; materials having such chemical functionality as a nucleophilic group and or a hydrogen bonding amine which, acting in concert with nanoconfinement and or chemical functionality of the surface or matrix to which the functionality is attached, acts catalytically by a mechanism related to that of the silicateins; and small-molecule non-polymeric biomimetic catalysts that operate by the same mechanism as silicateins. The substrate is selected from groups consisting of silicon alkoxides, non-silicon metalloid alkoxides or metal alkoxides, and any organic, organometallic or hydrido derivatives of the foregoing; inorganic and organic oxygen-containing chelates of silicon, non-silicon metalloids or metals and any organic, organometallic or hydrido derivatives of the foregoing; and inorganic and organic esters of the hydroxides of silicon, non-silicon metalloids or metals and any organic, organometallic or hydrido derivatives of the foregoing; and inorganic and organic hydrolyzable salts, complexes or conjugates of the hydroxides of silicon, non-silicon metalloids or metals and any organic, organometallic and hydrido derivatives of the foregoing.